



Two Career Fire Fighters Seriously Injured during Swiftwater Rescue Training at a Low-Head Dam – Ohio

SUMMARY

On April 17, 2007, a 32-year-old male career fire fighter (Fire Fighter #1) nearly drowned and a 35-year old male career fire fighter (Fire Fighter #2) was seriously injured during river rescue training. The fire department was conducting their annual river rescue recertification and the fire fighters were practicing a two-boat tether maneuver technique directly downstream from a low-head dam. The primary rescue boat crossed the boil line and became stuck in the recirculating backwash directly below the low-head dam. The secondary rescue boat, which the two injured firefighters were operating, also crossed over the boil line and was pulled upstream into the backwash. The secondary rescue boat disintegrated after striking the dam. Both injured fire fighters operating the secondary rescue boat were seriously injured and spent several months in rehabilitation. Fire Fighter #1 was able to return to active fire service duty. Fire Fighter #2 was unable to return to active duty because of the extent of his injuries.

Key contributing factors identified in this investigation include: not maintaining the secondary boat at a near downstream angle from the primary boat to which it was tethered; continuation of the training evolution when the secondary boat lost its downstream angle from the primary boat and/or when the primary boat started approaching too closely to the boil line; a safe downstream distance of the secondary boat from the low-head dam was not maintained; tactics to prevent the primary boat from crossing past the boil line were not employed such as peeling-out or swamping the secondary boat prior to the primary boat becoming stuck in the low-head dam's backwash; difficulties in correctly judging distances and the power of moving water; use of a shorter than recommended tether between the boats; use of a large floatable rescue device that required the primary boat to maneuver very close to the low-head dam to provide for a throwing delivery of the rescue device into the recirculating backwash rather than a smaller device that could be delivered from a safer downstream distance; and use of a rescue procedure that directs the primary rescue boat to get "as close to the boil line as possible" rather than maintaining a safe distance from it.

The National Institute for Occupational Safety and Health (NIOSH), an institute within the Centers for Disease Control and Prevention (CDC), is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. In fiscal year 1998, the Congress appropriated funds to NIOSH to conduct a fire fighter initiative. NIOSH initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim. For further information, visit the program website at www.cdc.gov/niosh/fire or call toll free at **1-800-CDC-INFO** (1-800-232-4643).



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NIOSH investigators concluded that, in order to minimize the risk of similar occurrences, fire departments involved in swiftwater rescues at low-head dams should:

- *ensure that fire fighters training on swiftwater rescue techniques includes proper and consistent identification of the low-head dam's boil line and the point the rescue boat should not cross, and that this should occur prior to on-water exercises*
- *ensure that the secondary rescue boat is always maintained at a downstream angle from the primary rescue boat to which it is tethered and that the length of the tether is greater than 100 feet, with greater flow volumes necessitating longer tether lines*
- *ensure that the training instructor calls off the training evolution at any time a major safety violation occurs, such as the primary boat becoming too close to the boil line or the secondary rescue boat losing its downstream angle and starting to approach the low-head dam*
- *consider additional training in boat handling skills*
- *ensure that all fire fighters trained in swiftwater rescue are highly accomplished swimmers that have the ability to self-rescue if they unintentionally leave the safety of a rescue boat*
- *ensure that an incident safety officer is assigned during training and that additional resources are immediately ready to respond in the event of a training mishap, including additional rescue boats and rescue personnel wearing water safety personal protective equipment*
- *preplan their responses to low-head dams in their coverage area*
- *consider lower risk shore-based rescue techniques in the risk versus gain analysis of their swiftwater responses*

Fire service training organizations should:

- *consider re-evaluating the Two-Boat Tether rescue technique*

INTRODUCTION

On April 17, 2007, a 32-year-old male career fire fighter (Fire Fighter #1) nearly drowned and a 35-year old male career fire fighter (Fire Fighter #2) was seriously injured during river rescue training. The fire fighters were practicing a two-boat tether maneuver directly downstream from a low-head dam to simulate a low-head dam rescue scenario. On April 18, 2007, the fire department notified the



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National Institute for Occupational Safety and Health (NIOSH) of this incident. On May 7-9, 2007, two safety and occupational health specialists from the NIOSH Fire Fighter Fatality Investigation and Prevention Program investigated this incident. The NIOSH investigators met with officials of the fire department and representatives from the International Association of Fire Fighters (IAFF). The team interviewed the officers and fire fighters involved in the incident, visited the incident site, examined photographs taken during the training, and reviewed other pertinent documents including the investigative report conducted by the fire department. The NIOSH investigators also reviewed departmental standard operating procedures,¹ dispatch records, radio communication transcripts, fire fighter training records and maintenance records.

FIRE DEPARTMENT

The career fire department involved in this incident has 118 employees and serves a population of more than 65,000 residents in a geographic area of 21.6 square miles from 6 fire stations. The department's geographic area also covers about 0.5 square miles of water from two rivers. The department has two low-head dams in their coverage area.

TRAINING and EXPERIENCE

The fire department's training bureau provides a 40-hour orientation for all new fire fighters. After the orientation is complete, recruits attend the State Fire Academy for the state required 280-hour career fire fighter certification training. After graduating from the academy, fire fighters complete a 36-month apprenticeship program that includes monthly written evaluations as well as monthly practical skill training. The department provides specialized training in swiftwater rescue, confined space rescue, high angle rope rescue, and ice rescue. All firefighters are required to be certified as Fire Inspectors by the state and the city. The department's training bureau also coordinates and supervises monthly training on various topics. Fire fighters were attending the annual river rescue recertification (awareness and technician levels) when the incident occurred. The department's swiftwater training program is conducted in-house and was based on guidance from the Ohio Department of National Resources water safety program.

EQUIPMENT and PERSONNEL

There were 16 fire fighters at the site of the low-head dam for the river rescue training. Other on duty fire department crews were on scene observing the training.

Instructor	Captain
Students	Awareness Level – Deputy Chief, Lieutenant, and a fire fighter Technician Level – 2 Lieutenants, Fire Fighters #1 & #2, and 8 other fire fighters



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Primary Boat – Avon 16-foot inflatable boat with a 20-horsepower outboard motor (see Photo 1).

Secondary Boat – 20-foot Jon boat (flat bottomed aluminum hulled) with a 35-horsepower outboard motor. Boats were equipped with tether rope, paddles/oars, ring buoy, rope throw bags, and first aid kits. Boats were trailered to the river with department sport utility vehicles.

TIMELINE

Note: This timeline is provided to set out, to the extent possible, the sequence of events. Times are approximate and were obtained from review of the dispatch records, witness interviews, photographs of the scene and other available information. In some cases the times may be rounded to the nearest minute, and some events may not have been included. The timeline is not intended, nor should it be used, as a formal record of events.

The key events include:

- **0800-1300 Hours**
Fire fighters begin training at fire station and safety checks were conducted on the boats
- **1315 Hours**
Fire fighters arrive at low-head dam site and begin on-water training
- **1604 Hours**
Primary and secondary boats cross the boil line^a into backwash
Primary boat trapped at the face of the dam
Secondary boat capsized and destroyed
Training instructor radios dispatch and requests general alarm
Engine 4, Car 15, Medic 2 dispatched to incident scene
- **1605 Hours**
Fire Fighter #2 washed downstream and rescued
Medic 3 dispatched to incident scene
- **1607 Hours**
Car 15 and Medic 2 arrived on the scene

^a The boil line is the boiling, bubbly area downstream of the low head dam where the water rises to the surface. The water upstream of the boil line is aerated and white, while the water downstream of the boil line has a darker, smoother appearance.



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- **1629 Hours**
Primary boat pulled from backwash with entangled Fire Fighter #1
Life support started on Fire Fighter #1

PERSONAL PROTECTIVE EQUIPMENT

At the time of the incident, the injured fire fighters were wearing their duty uniforms (some fire fighters were wearing tee shirts/shorts) with the appropriate personal protective equipment for swiftwater rescue, consisting of a water rescue helmet, gloves, a personal flotation device (PFD) with whistle and rescue knife. Wet suits or dry suits were available to fire fighters but were not worn during the training. Fire fighters had portable radios on scene, but were relying on hand signals during the incident training evolution.

INCIDENT LOCATION

Low-Head Dam

A low-head dam is a dam of low height (usually less than fifteen feet high) made of timber, stone, concrete, and other structural material.² The low-head dam in this incident extended from bank to bank across the river for a total distance of 450 feet (see Photo 2). There are observation decks on both river banks. The height of the dam is approximately 5-6 feet with an angle of decline of about 60 degrees. This low-head dam was constructed in the late 1980s to make the water deep enough for recreational boating and fishing. Since then, there has been a risk of boaters getting trapped in the recirculation backwash below the dam. Low-head dams are deceptively dangerous and have been given the name, "drowning machines."³

Water flowing over the dam forms a hydraulic at the base which can trap objects that are washed over the dam. Backwash or re-circulating current is formed below the dam (see Photo 3). Once swept over the dam, a victim becomes trapped and is forced underwater, pushed away from the dam, then circulated to the top. The circulating motion then repeats the cycle over and over again as the individual is drawn back or "recirculated" against the base of the dam. Unlike "normal" rapids, the moving water below the dam flows back upstream and carries objects back toward the dam. The boat motor or paddling efforts are powerless against the river due to the amount of air in the water. Almost anything with buoyancy will be trapped in this recirculating motion.

Low-Head Dam Rescues

Low-head dam rescues can either be shore or boat based. Shore-based rescues are usually used on dams that are less than 300 feet wide and have access on both sides. If rescue by a thrown hand line is not possible, a line is placed across the river referred to as a "tag-line". The line can be shot across with a line gun or by using a boat downstream of the dam. Rescuers on either side of the river will



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move the line with a rescue buoy attached to the victim who is then pulled to shore. A boat-based rescue is required on dams where access to both ends is not possible or the dam is wider than 300 feet. This method requires two boats which are connected together with a safety line.

Two-Boat Tether

The Two-Boat Tether is the operation where two boats are used to perform a rescue below a low-head dam. Two fire fighters are in each boat, a boat operator and a rescuer. In this operation the two boats are tethered by a length of rope (see Photo 4). This technique provides back-up for the primary boat working near the dam, should the primary boat need assistance or rescue. The primary boat (usually an inflatable raft) is the rescue boat that approaches the boil. The secondary boat is usually hard-hulled and acts as the safety boat keeping the primary boat from being pulled into the dam's backwash. The secondary boat usually remains 100-150 feet downstream from the face of the dam. The incident commander stands on the river bank, providing hand signals to the boats. The right hand commands the inflatable raft and the left the hard-hull safety boat. The primary boat approaches the dam from downstream and the rescuer will toss a flotation device on a line to the trapped victim. The victim will be pulled to the rescue boat. The incident commander guides the boats to the rescue location which can be hard to see over the boil when viewed from a boat.

Fire department personal recall three occasions since the late 1980s that the rescue boat was pulled into the "backwash" of the boil and the secondary boat was able to maneuver the rescue boat to safety. During these incidents, the bow of the rescue boat was on or slightly past the boil line and the river level was low. Several fire fighters interviewed during the investigation felt that during the evolutions prior to the incident they were operating too close to the boil line. It is estimated that the tether distance during the incident evolution was less than 100 feet and was probably in the range of 75-100 feet.

WEATHER

At the time of the incident the temperature was approximately 69 degrees Fahrenheit (°F) with a dew point of 33°F and a relative humidity of 26 percent.⁴ The sky was clear with variable winds with an average wind speed of 3.5 mph with gusts up 18.4 mph. The temperature of the water was estimated to be about 50-55°F.

INVESTIGATION

The live on-water river rescue recertification training began at 1315 hours, conducted on a river just below a low-head dam. The first training evolutions included boat handling and setting up a tag line with a moveable control point across the river (see Photo 5). At the completion of these evolutions, the Deputy Chief returned to headquarters. (*Note: Fire fighters recertifying at the awareness level do not go on the water*). The instructor then started several evolutions of the two-boat tether by the



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first group of 4 fire fighters recertifying at the technician level. A second group of fire fighters successfully completed their evolutions prior to the incident. The injured fire fighters were part of a third group recertifying at the technician level. The Captain (instructor) in charge of the training was debriefing the crews who had just completed their two-boat tether evolutions. A technician-level trained Lieutenant was on the deck directing the boat crews acting as the incident commander when the incident occurred.

Fire Fighters in the Water

At 1604 hours, both the primary and secondary boats approached the backwash of the dam. The injured fire fighters in the secondary boat saw the rescue boat pass the boil line and enter the backwash. Fire Fighter #1 started pulling on the tether line but their boat was unable to maneuver the rescue boat to safety. The secondary boat headed straight towards the dam, to the left of the rescue boat. The water upended the secondary boat, throwing Fire Fighters #1 and #2 into the raging water. The secondary boat disintegrated as it struck the dam (*Note: It is believed that pieces of the boat struck and injured Fire Fighter #2 in the water*).

The two firefighters in the primary boat maintained their position in their boat that was teetering against the dam. Immediately upon notification of the firefighters in the water, the instructor called dispatch for a general alarm response to the dam noting that fire fighters were in the water. At 1604 hours, Car 15, Engine 4, and Medic 2 responded to the incident scene. At 1605 hours Medic 3 responded to the dam. Car 15 and Medic 2 arrived on the scene at 1607.

Training Turns into Rescue

Immediately after the boats went into the backwash, an officer ran down to the remaining Avon boat, and along with a fire fighter, readied it for a possible rescue effort. As this was happening, Fire Fighter #2 was flushed out of the boil and swum downstream still wearing his PFD. A fire fighter on the river bank waded out into the water and grabbed him while another fire fighter threw him a rope. Together they got the injured fire fighter to shore. Once out of the river, medics began patient care and within a few minutes, transported him to the emergency room of the local hospital where he was admitted.

On the dam platform, a rope was thrown to the two fire fighters trapped in the primary boat at the face of the dam. The rope became entangled between the motor and transom of the boat. One fire fighter pulled himself, hand over hand on this rope, across the boil, dropped into the water and made his way to shore. The other fire fighter followed in the same manner.

On-shore fire fighters saw Fire Fighter #1 "re-circulating" in the boil, as the water ripped off his PFD, helmet and T-shirt. The instructor assigned a fire fighter to be a "spotter" to keep track of Fire Fighter #1's location in the backwash. He continued to re-circulate for a few minutes until he was no longer seen. An officer and fire fighter proceeded to launch the remaining boat and headed toward the dam. The instructor radioed for them to return to the shore.



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Fire fighters were planning to shift from rescue to recovery. The instructor talked with a fire fighter about assembling a team to conduct a tag line recovery. After getting the boat ready for the tag line, fire fighters had several discussions with the instructor about the recovery attempt. The officers on scene decided to try and remove the primary boat using the rope that had become entangled with it. After several attempts to pull the boat out by hand, the rope was attached to a Medic unit near the platform, and after re-positioning the rope, the boat was pulled out of the backwash by the apparatus.

Fire Fighter Nearly Drowns

At approximately 1629 hours, the primary boat was pulled out of the backwash. As the boat was pulled to shore, Fire Fighter #1 was found to be entangled in the ropes attached to the back of the rescue boat. Multiple firefighters ran to the rescue boat as it was retrieved to shore to help. Fire fighters immediately started mouth-to-mouth resuscitation. An officer cut Fire Fighter #1 from the entangled ropes. He was placed onto a backboard and carried to the medic unit where life saving efforts continued. He was transported to an area hospital and later transported by helicopter to a metropolitan trauma center.

FIRE FIGHTER INJURIES

Fire Fighter #1 was under water approximately 25 minutes and admitted to the trauma center in critical condition. He was on life support and suffering from hypothermia with a body temperature of 80°F. It is hypothesized that he survived due to the river's cold temperature which slowed bodily functions and minimized damage to his vital organs. He suffered no brain injury and after several weeks of rehabilitation he was able to return to active duty. He had no recollection or memory of the incident.

Fire Fighter #2 suffered leg, head and spinal injuries and was transported to a regional trauma center. Fire fighter #2 spent several months in rehabilitation and due to the extent of his injuries, was unable to return to active duty in the fire service.

CONTRIBUTING FACTORS

Occupational injuries are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. NIOSH investigators identified the following items as key contributing factors in this incident that ultimately led to the injuries:

- not maintaining the secondary boat at a near downstream angle from the primary boat to which it was tethered
- continuation of the training evolution when the secondary boat lost its downstream angle from the primary boat and/or when the primary boat started approaching too closely to the boil line



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- a safe downstream distance of the secondary boat from the low-head dam was not maintained
- tactics to prevent the primary boat from crossing past the boil line were not employed such as peeling-out or swamping the secondary boat prior to the primary boat becoming stuck in the low-head dam's backwash
- difficulties in correctly judging distances and the power of moving water
- use of a shorter than recommended tether between the boats
- use of a large floatable rescue device that required the primary boat to maneuver very close to the low-head dam to provide for a throwing delivery of the rescue device into the re-circulating backwash rather than a smaller device that could be delivered from a safer downstream distance
- use of a rescue procedure that directs the primary rescue boat to get "as close to the boil line as possible" rather than maintaining a safe distance from it.

RECOMMENDATIONS

Recommendation #1: Fire departments should ensure that fire fighters training on swiftwater rescue techniques includes proper and consistent identification of the low-head dam's boil line and the point the rescue boat should not cross, and that this should occur prior to on-water exercises.

Discussion: Several fire fighters interviewed felt that during the evolutions prior to the incident they were operating too close to the boil line. The primary rescue boat must maintain a safe distance downstream from the boil. The perception of the boil line can be difficult to judge especially while on the water. The location of the boil is more accurately judged from the river bank. During swiftwater training, fire departments should consider a safety factor and add some distance to the boil line that the rescue boat does not cross. Other factors that should be considered to prevent the rescue boat from being drawn across the boil line include the hydraulic forces of the moving water, the pull of the hydraulics on the rescue buoy and the effect of aerated water on the outboard motor propeller. Dry-land training should be completed prior to any live on-water exercise. The boil line is not a static location. The more symmetric the backwash appears across the river, the more static the boil line will be, but obstructions to the current (both surface and underwater, and above and below the dam) create water properties that lead to variations in the boil line.

Recommendation #2: Fire departments should ensure that the secondary rescue boat is always maintained at a downstream angle from the primary rescue boat to which it is tethered and that the length of tether is greater than 100 feet, with greater flow volumes necessitating longer tether lines.

Discussion: The Ohio Department of Natural Resources devised the two-boat tether maneuver for low-head dam rescues.⁵ They recommend that the tether distance between the two boats be at least 100-150 feet (30-45 meters). It is estimated that the tether distance during the incident evolution was less than 100 feet and was probably in the range of 75-100 feet. This distance was inadequate to



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allow the secondary boat to react and pull the rescue boat from past the boil line. The secondary boat needs the extra distance of tether to be able to peel-out (quickly executing a power turn downstream) and power the rescue boat to safety.⁵ Secondary boat operators should also be prepared to swamp the boat if necessary to act as an anchor to keep the primary boat outside the boil line. In this incident, the large floatable rescue device (a ring buoy) required that the primary boat maneuver too close to the low-head dam to throw the rescue device into the re-circulating backwash rather than a smaller device that could be delivered from a safer downstream distance, such as a rope throw bag.

Recommendation #3: Fire departments should ensure that the training instructor calls off the training evolution at any time a major safety violation occurs, such as the primary boat becoming too close to the boil line or the secondary rescue boat losing its downstream angle and starting to approach the low-head dam.

Discussion: In this incident the primary boat became too close to the boil line and entered the dam's backwash. It is critical that this scenario be prevented to avoid the rescuers from becoming potential victims.⁵ Fire departments should immediately halt any two-boat tether training evolutions that could jeopardize fire fighter safety. Additional personnel should assist the incident commander or training instructor in determining when to call off the training attempt if any major safety violations are observed (e.g., secondary boat's downstream angle, primary boat too close to boil, etc.)

Recommendation #4: Fire departments should consider additional training in boat handling skills.

Discussion: The two-boat tether maneuver is an intricate technical rescue that requires exceptional boat handling skills.⁵ Some fire fighters interviewed reported recreational boating as a hobby and were boat owners. Many other fire fighters reported that they only operate a boat once a year during their annual river rescue recertification. Fire departments should consider additional training in boat operations for fire fighters with limited boat handling skills. It is mandatory that fire fighters operating boats have good skills and that additional training in boat handling is scheduled on a regular basis to maintain their skill level, including recognition that the boats' power is lost once the propeller is in the aerated water of the dam's boil. Fire departments should ensure that only the most experienced rescuers with good boat handling skills are assigned to river rescue duty. Fire departments should determine if all fire fighters should routinely qualify in the two-boat tether, especially if river conditions are less than ideal.

Recommendation #5: Fire departments should ensure that all fire fighters trained in swiftwater rescue are highly accomplished swimmers that have the ability to self-rescue if they unintentionally leave the safety of a rescue boat.

Discussion: Rescuers must quickly establish and remember rescue priorities; the safety of the rescuers is paramount. Swiftwater rescue technicians should be highly accomplished swimmers with the ability to rescue themselves in the event they unintentionally leave the safety of the rescue boat.



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Recommendation #6: Fire departments should ensure that an incident safety officer is assigned during training and that additional resources are immediately ready to respond in the event of a training mishap, including additional rescue boats and rescue personnel wearing water safety personal protective equipment.

Discussion: Fire departments should ensure that an incident safety officer (ISO) is designated and assigned to oversee all training exercises.^{6,7} Fire departments should have another two boat crew staged and ready to respond during two-boat tether training evolutions. In this incident, the primary boat was trapped at the dam's face and the rescue boat was destroyed. The fire department had no means available to perform the two-boat tether, which was required in response to this training mishap. Fire departments should have a swiftwater rescue rapid intervention team available as a backup resource for both training and actual events. If fire departments do not have the manpower or funds for a second crew they should consider training and responding with other mutual aid departments. Fire fighters should continue wearing life jackets even while watching the training from ashore. Fire fighters should also be wearing thermal protection such as wet or dry suits, even on warm training days.

Recommendation #7: Fire departments should preplan their responses to low-head dams in their coverage area.

Discussion: Fire departments with swiftwater rescue teams should preplan the low-head dams in their coverage area. Fire departments should inspect the low-head dam at a very low flow rate for the dam's condition and underwater obstructions. Daily shift briefings should include current weather (temperature and wind speed/direction) and river conditions (i.e. current water levels, dam water flow rate, surface loads (debris or ice), boil location and water temperature). Wind blowing in the upstream direction can push the stern of the rescue boat past the boil line. Fire departments should avoid two-boat tether training in times of high water, and should attempt to establish "safe" river levels for training operations.

Recommendation #8: Fire departments should consider lower risk shore-based rescue techniques in the risk versus gain analysis of their swiftwater responses.

Discussion: The tag line rescue is a boat-assisted shore-based rescue technique that has lower risks than a boat-based rescue.⁵ A tag line rescue can usually be deployed faster, only requires one boat to cross the river, the boat does not need to approach near the boil, and requires fewer fire fighters on the water. In this incident, the low-head dam has observation decks on both banks that would have facilitated the tag line technique.

Recommendation #9: Fire service training organizations should consider re-evaluating the Two-Boat Tether rescue technique.

Discussion: Fire service training organizations should consider re-evaluating the two-boat tether rescue technique with respect to the forces required to overcome the strength of the hydraulic energy



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exerted on a trapped victim and/or rescue boat. Also directives to maneuver the primary rescue boat as close as possible to the boil line should be re-evaluated.

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INVESTIGATOR INFORMATION

This incident was investigated by CDR Steve Berardinelli and Jay Tarley, Occupational Safety and Health Specialists with the Fire Fighter Fatality Investigation and Prevention Team, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. A technical review was provided by Slim Ray, author of Swiftwater Rescue: A Manual for the Rescue Professional.



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Photo 1. Primary or rescue boat (shown without outboard motor).
(NIOSH photo.)



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Photo 2. Incident location.
(NIOSH photo.)



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Photo 3. Low-head dam backwash.
(NIOSH photo.)



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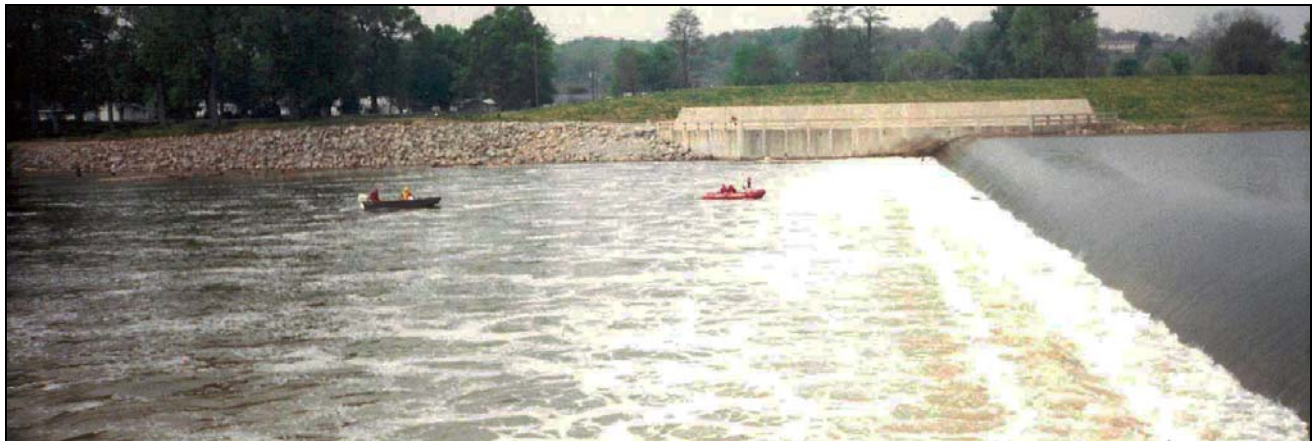


Photo 4. Two-boat tether training evolution.
(Note: This photo was taken during previous training at incident site)
(*Photo courtesy of fire department.*)



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Photo 5. Fire fighters training on the day of the incident extending a tag line between river banks prior to the two-boat tether evolutions.
(Photo courtesy of fire department.)